USGS

WATER RESOURCES RESEARCH GRANT PROPOSAL

Title: The role of riparian habitats and stream networks in facilitating the spread of exotic species

Investigator: Colleen A. Hatfield

Amount Requested: $12,500

Rationale

Few if any ecosystems remain that have not been affected by invading species, either through natural invasions or by anthropogenic introductions. While the paleological records reveal that invasions are not uncommon (Graham 1988, Vermeij 1991), what has changed in the recent past is the acceleration of invasion events, often anthropogenically induced. Invading species can alter ecosystem function (Walker and Vitousek 1991, D'Antonio and Vitousek 1992), population dynamics (Pulliam 1988) and community structure (Olsen et al. 1991, Nalepa and Schloesser 1993). Considerable effort has been directed towards trying to better understand invasion dynamics in an attempt to improve our ability to identify what makes a system, community or specific species more susceptible to invasion, or how and when invading species might disrupt system function (Crawley 1986, Drake et al. 1989). We are beginning to gain some insight into certain aspects of invasion dynamics, such as common traits that frequently characterize successful invading species (Townsend 1991, Lodge 1993), but there still remains a large disparity between what we do know about invasion dynamics and what we need to know in order to understand and effectively manage invading species in ecological systems.

The spatial distribution of habitat resources is integral to the ability and propensity of invading species to become established and spread through the system, across systems and over the landscape. In addition, the physical characteristics and biotic processes that closely link a particular community to the environment are important considerations in determining a system's susceptibility to invading species as well as the potential for the organism to spread to the surrounding environment (Case 1991, Hengeveld 1994). This proposed research will focus on if and how the spatial configuration and associated characteristics of a habitat might facilitate the spread of exotic species. Stream networks and associated riparian habitats will be used as model systems to study how the spatial connectivity and configuration of habitat resources might influence the extent of exotic riparian plant distributions in drainage networks.

In heavily populated regions such as New Jersey, protected areas set aside in preserves, parks, watersheds, greenways and forests continue to experience multiple stressors including declines in water quality and species biodiversity, and increased fragmentation in bordering land. Each of these stressors can potentially prime the system for the establishment and spread of invading species. Thus understanding how features of the system potentially increase or decrease its susceptibility to invading species are important

in the ability to manage and protect the biodiversity and ecological functioning of an area.

Background

Species-rich communities are thought to be more resistant to invasion than less speciose communities (Elton 1958, McNaughton 1993 , Tilman 1997). Resource utilization tends to be more efficient when there are more species present in a habitat which results in less available resource for successful establishment of invading species. In turn, habitats with low species richness are more susceptible to invasion as there are fewer species utilizing the available resource pool. Empirical studies (McNaughton 1983, Tilman 1982, 1997) and theoretical studies (Post and Pimm 1983, Case 1991) have supported this concept. However, some studies have pointed out instances where species rich habitats actually supported more exotic species than nearby less speciose habitats (DeFerrari and Naiman 1994, Robinson et al. 1995, Stohlgren et al. 1998a). Species-rich communities are not necessarily static with species composition changing through time (May 1973). As native species drop out of the community, invading species can potentially colonize newly vacated space and co-exist as long as critical resources are not limiting. Thus, species rich communities can also be susceptible to invasions.

Disturbance can play a key role in creating opportunities for invading species to colonize even species-rich habitats (Robinson et al. 1995). Openings created by disturbance become available for colonization for both local and invading species. The periodicity and extent of disturbance influences how frequently opportunities for invasion occur, while the resource availability, and characteristics of the community and invading species will determine the ability of the invading species to become successfully established and as well as its tendency to spread into the surrounding environment.

The ability and propensity of an invading organism to spread in the environment can determine the extent and magnitude of its impact on the system and the surrounding landscape. Once established, the ability to spread beyond the local point of colonization into the surrounding environment is determined in large part by its ability to capitalize on the abiotic and biotic features of the environment. An additional key component in determining the propensity of an invading organism to spread is the positioning and proximity of essential habitat elements in the landscape. Even if resources are abundant in the landscape, if they are not homogeneously dispersed then arrangement and distance between resource patches can potentially determine available habitat for the invading species. For example, if resources are patchily distributed in a highly heterogeneous landscape, then these resources may not represent accessible or available habitat. This would effectively limit dispersal of organisms beyond the initial point of colonization. The spatial context of habitat elements and resource heterogeneity are fundamentally important in population and metapopulation dynamics (Kareiva 1990, Gilpin and Hanski 1991, Hassell et al. 1991), community structure (Huston 1979, Pacala and Silander 1990, Tilman 1994) and ecosystem function (Lubina and Levin 1988, O'Neill et al. 1991, Kareiva 1990, 1994) Thus, understanding the how the spatial distribution of habitat types

may influence the potential spread of invading organisms will help to determine the impact of these species on communities, ecosystems and landscapes.